Unit IV: Plant Growth

Lesson 4: Nutrients

Without nutrients, plants cannot grow. This lesson identifies the impact of macro- and micronutrients, oxygen, hydrogen, and carbon, and it addresses the consequences if deficiencies occur. Factors that affect availability of nutrients into the plant are also outlined.

There is a distinction between "plant nutrition" and "plant fertilization." Plant nutrition indicates specific chemical elements that are available (absorbed) in the plant. Plant fertilization is a procedure of adding more nutrients to supplement the growing medium. (Fertilizers are discussed in the next lesson.)

Effect of Nutrients on Plant Growth

All plant growth and development depend upon proper nutrition. Each type of plant needs adequate levels of minerals to grow at an optimum rate. Insufficient and excessive amounts of nutrients hinder plant growth. Greenhouse plants need more supplemental nutrients than other agricultural crops. They also require applications of fertilizers as nutritional supplements to promote plant growth.

Essential Nutrients for Plant Growth

The minerals that plants need are divided into two groups: macronutrients (major nutrients) and micronutrient (minor, or trace elements). These minerals are actually forms of soluble salt. Table 4.3 lists these nutrients.

Table 4.3 - Essential Plant Macronutrients and Micronutrients

Macronutrients	Micronutrients
Primary	Boron (B)
Nitrogen (N)	Chlorine (Cl)
Phosphorous (P)	Copper (Cu)
Potassium (K)	Iron (Fe)
Secondary	Manganese (Mn)
Calcium (Ca)	Molybdenum (Mo)
Magnesium (Mg)	Nickel (Ni)
Sulfur (S)	Sodium (Na)
	Zinc (Zn)

A primary macronutrient, *nitrogen*, is essential to growth and is found in chlorophyll and enzymes. It helps the plant resist disease and sustain environmental extremes, such as drought and freezing. Nitrogen is recycled within the plant. Plants absorb nitrogen as nitrate ions, its inorganic form. By becoming part of the plant's tissue, the nitrate ions change into an organic form. When the plant dies, the plant tissues decompose. This releases the organic form of nitrogen as inorganic ions.

Phosphorous stimulates root growth and promotes early crop maturity. *Potassium* contributes to growth of plant tissue.

As a secondary macronutrient, *calcium* increases the pH level, which corrects acidity in the growing medium. It is a key factor in cell development and affects the roots' ability to absorb magnesium and potassium. *Magnesium* is important because it helps produce chlorophyll, fats, and sugars. *Sulfur*, used in all plants, is absorbed in some vegetables (e.g., cabbage and onions). It is a part of the plant's vitamins and amino acids and assists in producing protein.

The micronutrients are not less important than macronutrients; less is needed. These trace minerals, in varying quantities, affect photosynthesis, protein synthesis, cell development, flowering, and other plant processes.

Other essential nutrients are oxygen, hydrogen, and carbon, which represent 89% of the plant's content by dry weight. Obtained from the atmosphere and water in huge amounts, these elements are always available to the plant.

Identifying Nutritional Deficiencies

The greenhouse owner should establish and follow a monitoring system to determine if plants have adequate nutrients. Signs of deficiency vary with species and may be visible only in the later stages of development, at which point remediation may not be possible. Attempting to identify nutritional deficiencies just by visual means may be insufficient.

Analyzing leaf tissue and the growing medium yields important information that can prevent nutritional deficiencies from developing. If the medium lacks essential minerals, the plant cannot access them. An inappropriate pH level, presence of soluble salts, and presence of pests and disease can stifle plant growth.

Two key terms are used to identify nutritional deficiencies: chlorosis and necrosis. *Chlorosis* is the gradual yellowing of tissues as green chlorophyll breaks down. Interveinal chlorosis is yellowing between leaf veins. *Necrosis* refers to dead tissue that appears as brown or black.

Macronutrient Disorders

Macronutrient deficiencies harm plant growth. If a plant does not have enough nitrogen, its growth is stunted. It produces spindly, fewer, lateral shoots. The older and lower leaves are the first to become chlorotic. *Nitrogen* can be lost through soil erosion and leaching, which wash important nutrients through the medium. Excess nitrogen in the growing medium delays development of fruit.

If the medium lacks *phosphorous*, growth is stunted and spindly, leaves and stems become a deeper green, and the veins and stems are purplish. Flowering is diminished and crop yield is reduced.

Insufficient amounts of *potassium* reduce plant growth and cause dead spots on leaves. Too much potassium without the addition of the micronutrient zinc causes a zinc deficit. Interveinal chlorosis develops, beginning with older leaves. Necrotic or scorched edges develop, beginning with older leaves

Bud growth stops and root tips die if there is an insufficiency of *calcium*. New leaf tips turn yellow, brown, or black. The growing points die back and roots become short and thick. Too much calcium prevents other minerals from reaching the plant. A deficiency of *magnesium* is evident when the center of older leaves begins to show interveinal chlorosis. Leaf edges start to show necrosis and marginal scorching.

A deficiency of *sulfur* exhibits chlorosis in a similar manner as nitrogen but does not necessarily begin with the older leaves. Leaves may turn orange or red and the stems become hard.

Micronutrient Disorders

Micronutrient deficiency occurs when the plant develops symptoms that are often similar to macronutrient deficiency. Even minor deficiencies can affect plant growth. Symptoms may be difficult to recognize. The pH of the medium must be in the correct range to ensure that the micronutrients can be taken up into the plant.

An additional problem occurs if excessive amounts of micronutrients are applied (toxicity). An excessive concentration of one nutrient in the medium prevents other nutrients from providing available nourishment to the plant. For example, too much iron robs the plant of manganese; a surplus of copper causes a deficit of zinc. Typically, excesses result from applying multiple mixtures of micronutrients. Decreasing the pH level makes all micronutrients available except molybdenum.

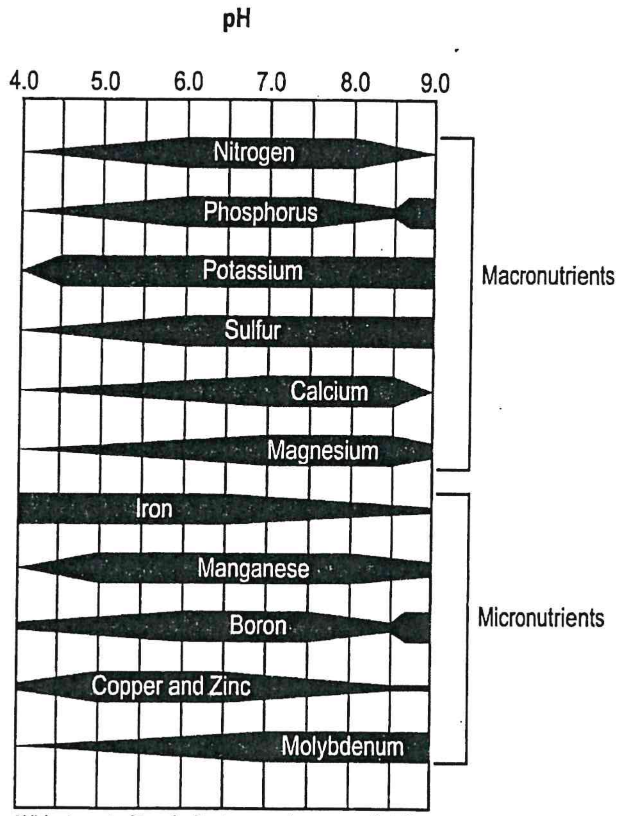
To ensure that plants receive the correct amounts of micronutrients, spray the foliage during the early morning when nutrient uptake through the moist leaves is greater.

Factors Affecting the Availability of Nutrients

As discussed in Lesson 2 in this unit, the pH level of the medium is a critical factor in plant growth. It controls the availability of nutrient uptake into the plant. The pH level alters in response to the accumulation of fertilizer residues in the growing medium and residues from irrigation systems. Consequently, monitoring each plant's pH is important. The macro- and micronutrients are available to plants only at specific pH levels.

It is important to test the pH levels in the growing medium regularly. To correct field soil that is too acidic, add lime (calcium) to increase the pH. To adjust overly alkaline soil, add sulfur, which decreases the pH. Figure 4.10 illustrates how field soil pH affects the availability of nutrients.

Figure 4.10 - Effect of Field Soil's pH on Nutrient Availability

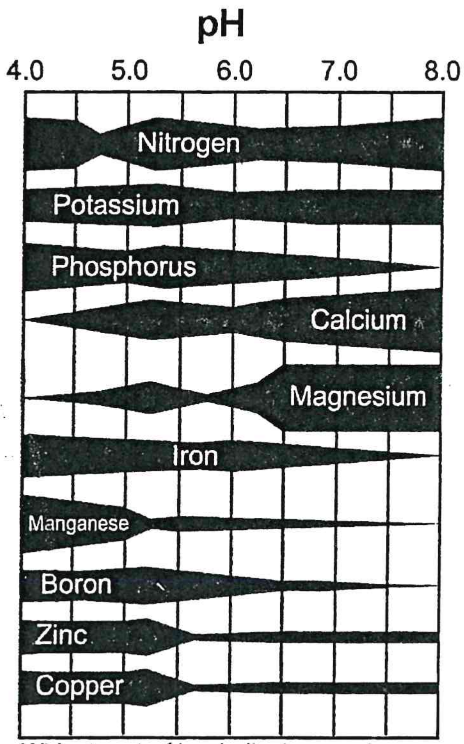


Widest part of bar indicates maximum availability.

Adapted from *Introduction to Horticulture*, 3rd ed., Danville, IL: Interstate Publishers, Inc., 2000.

The pH of soilless media also has an effect on the availability of nutrients, as seen in Figure 4.11.

Figure 4.11 - Effect of Soilless Medium's pH on Nutrient Availability



Widest part of bar indicates maximum availability.

Adapted from Nelson, Paul V., *Greenhouse Operation and Management*, 3rd ed., Reston, VA: Reston Publishing Company, Inc., 1985.

Accumulated soluble salts can greatly diminish plant growth. Some plants are more sensitive than others, especially young plants. These salts result from low-quality water, fertilizer residues, and salts in the growing medium. Irrigation water contains sodium, calcium, magnesium, and often other elements. They are measured by levels of electrical conductivity (EC). The higher the amount of salt, the greater the EC. As forms of salt, fertilizers also add increased levels to the growing medium. The growing medium, depending upon its constituents, may have excessive levels of soluble salts.

Excessive amounts can damage or kill the root system, thereby increasing the risk of disease and limiting the uptake ability. Soluble salts can deprive plants of nutrients and cause slow growth. They translocate throughout the plant, causing injury to tissues, such as mild chlorosis and leaf burn. Another consequence is reduced water intake into the plant, which causes wilting. Foliage is also injured.

To prevent and correct excessive buildup of soluble salts, the greenhouse owner should use a salinity meter to check the water quality, refer to a salt index to determine if the fertilizer is suitable, and ensure that the growing medium is highly porous. It is important to maintain an adequate moisture level. Applying large amounts of water that allow 15-20% to leach out of the container flushes out concentrated soluble salts from the growing medium.

Pests and diseases can damage roots and prevent plants from efficiently absorbing nutrients. The effects of pests and diseases are discussed in more detail in Unit VI, Lesson 1.

Summary

Greenhouse plants, more than any other agricultural crop, need greater amounts of macro- and micronutrients. These sources of nourishment, along with ever-available oxygen, hydrogen, and carbon, affect every stage of development. Deficiencies or excesses of any of these key elements harm various plant parts and processes. The greenhouse owner can correct these disorders by adjusting the growing medium's pH level as needed and by leaching excessive soluble salts from the growing medium.

Credits

Bailey, Douglas A. and Paul V. Nelson. "Managing Micronutrients in the Greenhouse." North Carolina Cooperative Extension Service - Department of Horticultural Science. Horticulture Information Leaflet 553, revised August 1998. <http://www.ces.ncsu.edu/depts/hort/hil/hil-553.html> accessed 2/21/02.

Cooper, Elmer L. *Agriscience: Fundamentals & Applications*, 2nd ed. Albany, NY: Delmar Publishers, 1995.

Greenhouse Operation and Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory. 1990.

Lee, Jasper S., Series Editor. *Introduction to Horticulture*, 3rd ed. Danville, IL: Interstate Publishers, Inc., 2000.

"Managing Soluble Salts."<http://aggie-horticulture.tamu.edu/greenhouse/guides/green/salts.html> accessed 12/17/01

Nelson, Paul V. *Greenhouse Operation and Management*, 3rd ed. Reston, VA: Reston Publishing Company, Inc., 1985.